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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/009,910	12/12/2001	Makoto Iida	81839.0107	7347

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 01/16/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)
	10/009,910	IIDA ET AL.
	Examiner	**Art Unit**
	Matthew J Song	1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 October 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-10* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-10* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 10/14/2003 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Fujikawa (US 6,277,501).

Iida et al discloses a method of forming a silicon wafer with an N region formed over the entire surface by pulling a crystal from a silicon melt in a Czochralski method at a pulling rate, V, ranging between 0.55-0.58 mm/min and a G ranging from 42.0-45.0 °C/cm from the center to the edge of the silicon ingot, this reads on applicant's controlling V/G because V and G are controlled, therefore the ratio is inherently controlled (Example 1 and 2). Iida et al also discloses in order to establish the N region over the entire cross section of a crystal, a highly precisely control must be carried out. Also note that the entire reference has been incorporated into the basis of the rejection.

Iida et al does not disclose the silicon single crystal is pulled while doping with carbon.

In a method of forming a silicon wafer, note entire reference, Fujikawa teaches growing a silicon single crystal while controlling the oxygen concentration in the range of $12x10^{17}$-$18x10^{17}$ atoms/cm^3 and controlling the carbon concentration in the range of $0.3x10^{16}$-$2.5x10^{16}$ atoms/cm^3 (col 9, ln 1-67), where $2.5x10^{16}$ atoms/cm^3 of carbon approximately corresponds to 0.5 ppma (col 5, ln 1-67). Fujikawa also teaches annealing a wafer, containing specified amounts of oxygen and carbon, is annealed at 600-900°C for at least more than 15 minutes to achieve a BMD of over $3x10^8/cm^3$ (col 11, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Iida et al with Fujikawa to promote precipitation of oxygen, thereby producing an epi-wafer without an expensive EG treatment (col 6, ln 1-67 and col 7, ln 1-67).

The combination of Iida et al and Fujikawa et al is silent to the silicon single crystal being pulled at a rate greater than the rate of pulling a silicon single crystal with no carbon doping. Iida et al teaches through the adequate adjustment of the pulling rate, the N region can be formed over the entire crystal cross section (col 5, ln 10-15), which is a teaching that pulling rate is a result effective variable for forming a N-region. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Iida et al and Fujikawa et al by optimizing the pulling rate to obtain a pulling rate greater than the rate of pulling a silicon single crystal with no carbon doping conducting routine experimentation of a result effective variable.

Referring to claim 5, the combination of Iida et al and Fujikawa teaches annealing at 600-900°C, overlapping ranges are held to be obvious (MPEP 2144.05).

4. Claims 2, 6, 9-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (5,968,264) in view of Fujikawa (US 6,277,501) as applied to claim 1 above, and further in view of Tamatsuka et al (US 6,162,708).

The combination of Iida et al and Fujikawa teaches all of the limitations of claim 2, as discussed previously in claim 1, except the silicon single crystal is doped with nitrogen.

In a method of forming an epitaxial silicon wafer, note entire reference, Tamatsuka et al teaches a silicon single crystal doped with nitrogen in the range of $1x10^{10}$ to $5x10^{15}$ atoms/cm^3 and an interstitial oxygen concentration in the single crystal ingot is 18 ppma or less (col 2, ln 1-67). Tamatsuka et al also teaches annealing at 900°C (col 8, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of

Iida et al and Fujikawa with Tamatsuka et al because a silicon single crystal wafer produced by doping nitrogen during growth of the silicon crystal ingot has a high gettering capability, growth of grown in defects incorporated can be suppressed and density of oxide precipitates can be increased (col 6, ln 1-67).

Referring to claim 6, the combination of Iida, Fujikawa and Tamatsuka et al teaches annealing at 600-900°C. Overlapping ranges are held to be obvious.

Referring to claim 9, it is noted that claim 9 is a product claim, which recites process limitations. The patentability determination of a product-by-process claim is based on the patentability of the product and does not depend on its method of production (MPEP 2113). Therefore, the product taught by the combination of Iida, Fujikawa and Tamatsuka et al reads on the instantly claimed silicon wafer because the product limitations are taught by the combination of Iida, Fujikawa and Tamatsuka et al

5. Claims 3 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Fujikawa (US 6,277,501) as applied to claim 1 above, and further in view of Hourai et al (US 5,954,873).

The combination of Iida et al and Fujikawa teaches all of the limitations of claim 3, as discussed previously, except controlling V/G within a range of 0.183-0.177 mm^2/ K min.

Hourai et al discloses a V/G ratio of 0.183-0.177 mm^2/K min (Fig 2), where dislocation clusters form through the entire wafer, this reads applicant's N-region, where wafers are formed from a silicon single crystal ingot manufactured by the Czochralski method with careful control of the pulling rate and temperature gradient permit a crystal to be formed that is free of

Oxidation induced stacking fault rings and other defects (Abstract). Hourai et al also teaches V and G are important parameters for controlling the diameter of an OSF ring (col 4, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Iida et al and Fujikawa with Hourai et al because a larger V/G allows the crystal to be pulled faster, thereby increasing production.

6. Claims 4 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Fujikawa (US 6,277,501) and Tamatsuka et al (US 6,162,708) as applied to claim 2 above, and further in view of Hourai et al (US 5,954,873).

The combination of Iida et al, Fujikawa and Tamatsuka et al teaches all of the limitations of claim 4, as discussed previously, except controlling V/G within a range of 0.183-0.177 mm^2/ K min.

Hourai et al discloses a V/G ratio of 0.183-0.177 mm^2/K min (Fig 2), where dislocation clusters form through the entire wafer, this reads applicant's N-region, where wafers are formed from a silicon single crystal ingot manufactured by the Czochralski method with careful control of the pulling rate and temperature gradient permit a crystal to be formed that is free of Oxidation induced stacking fault rings and other defects (Abstract). Hourai et al also teaches V and G are important parameters for controlling the diameter of an OSF ring (col 4, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Iida et al, Fujikawa and Hourai et al with Hourai et al because a larger V/G allows the crystal to be pulled faster, thereby increasing production.

7. Claims 1, 3, 5, 7 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al (US 5,954,873) in view of Fujikawa (US 6,277,501).

Hourai et al discloses a V/G ratio of 0.183-0.177 mm^2/K min (Fig 2), where dislocation clusters form through the entire wafer, this reads applicant's N-region, where wafers are formed from a silicon single crystal ingot manufactured by the Czochralski method with careful control of the pulling rate and temperature gradient permit a crystal to be formed that is free of Oxidation induced stacking fault rings and other defects (Abstract). Hourai et al also teaches V and G are important parameters for controlling the diameter of an OSF ring (col 4, ln 1-67). Also note the entire reference has been incorporated into the basis of the rejection.

Hourai et al does not disclose the silicon single crystal is pulled while doping with carbon

In a method of forming a silicon wafer, note entire reference, Fujikawa teaches growing a silicon single crystal while controlling the oxygen concentration in the range of $12x10^{17}$-$18x10^{17}$ atoms/cm^3 and controlling the carbon concentration in the range of $0.3x10^{16}$-$2.5x10^{16}$ atoms/cm^3 (col 9, ln 1-67), where $2.5x10^{16}$ atoms/cm^3 of carbon approximately corresponds to 0.5 ppma (col 5, ln 1-67). Fujikawa also teaches annealing a wafer, containing specified amounts of oxygen and carbon, is annealed at 600-900°C for at least more than 15 minutes to achieve a BMD of over $3x10^8$/cm^3 (col 11, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai et al with Fujikawa to promote precipitation of oxygen, thereby producing an epi-wafer without an expensive EG treatment (col 6, ln 1-67 and col 7, ln 1-67).

The combination of Hourai et al and Fujikawa et al is silent to the silicon single crystal being pulled at a rate greater than the rate of pulling a silicon single crystal with no carbon

doping. Hourai et al teaches careful control of the pulling rate permits a crystal to be formed that is free of Oxidation induced stacking fault rings and other defects (Abstract), which is a teaching that pulling rate is a result effective variable for forming a N-region. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Hourai et al and Fujikawa et al by optimizing the pulling rate to obtain a pulling rate greater than the rate of pulling a silicon single crystal with no carbon doping conducting routine experimentation of a result effective variable.

Referring to claim 3, 5 and 7, the combination of Hourai et al and Fujikawa teaches a carbon concentration of 0.5 ppma and a V/G of 0.183-0.177 mm^2/K min and annealing at a temperature of 600-900°C. Overlapping ranges are held to be obvious (MPEP 2144.05).

Referring to claim 9, the combination of Hourai et al and Fujikawa teaches a wafer with dislocation clusters throughout the wafer pulled under a similar V/G condition, as applicant, therefore this reads on applicant's N-region. And a carbon concentration of 0.5 ppma. Also, it is noted that claim 9 a product claim, which recites process limitations. The patentability determination of a product-by-process claim is based on the patentability of the product and does not depend on its method of production (MPEP 2113). Therefore, the product taught by the combination of Hourai et al and Fujikawa et al reads on the instantly claimed silicon wafer because the product limitations are taught by the combination of Hourai et al and Fujikawa et al.

8. Claims 2, 4, 6, 8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al (US 5,954,873) in view of Fujikawa (US 6,277,501) as applied to claim 1 above, and further in view of Tamatsuka et al (US 6,162,708).

The combination of Hourai et al and Fujikawa teaches all of the limitations of claim 2, as discussed previously in claim 1, except doping with nitrogen.

In a method of forming an epitaxial silicon wafer, note entire reference, Tamatsuka et al teaches a silicon single crystal doped with nitrogen in the range of $1x10^{10}$ to $5x10^{15}$ atoms/cm^3 and an interstitial oxygen concentration in the single crystal ingot is 18 ppma or less (col 2, ln 1-67). Tamatsuka et al also teaches annealing at 900°C (col 8, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Hourai et al and Fujikawa with Tamatsuka et al because a silicon single crystal wafer produced by doping nitrogen during growth of the silicon crystal ingot has a high gettering capability, growth of grown in defects incorporated can be suppressed and density of oxide precipitates can be increased (col 6, ln 1-67).

Referring to claims 6 and 8, the combination of Hourai, Fujikawa and Tamatsuka teaches annealing at 600-900°C, overlapping ranges are held to be obvious (MPEP 2144.05).

Referring to claim 10, the combination of Hourai, Fujikawa and Tamatsuka teaches a nitrogen content of $1x10^{10}$-$1x10^{15}$ number/cm3, overlapping ranges are obvious.

9. Claims 1-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Asayama et al (US 6,641,888) in view of Iida et al (US 5,968,264) or Hourai et al (US 5,954,873).

Asayama et al teaches a silicon single crystal is doped with carbon and nitrogen and is sliced to from silicon wafers (Abstract). Asayama et al teaches a nitrogen concentration of $5x10^{13}$ atoms/cm^3 and a carbon concentration of $3x10^{16}$ atoms/cm^3 (Table 1 and Table 2).

Overlapping ranges are held to be obvious (MPEP 2144.05). Asayama et al also teaches the wafers are heat treated at 1000°C (col 10, ln 30-40).

Asayama et al is silent to the silicon single crystal is pulled while controlling V/G to have an N-region over an entire plane of the crystal.

Iida et al discloses a method of forming a silicon wafer with an N region formed over the entire surface by pulling a crystal from a silicon melt in a Czochralski method at a pulling rate, V, ranging between 0.55-0.58 mm/min and a G ranging from 42.0-45.0 °C/cm from the center to the edge of the silicon ingot, this reads on applicant's controlling V/G because V and G are controlled, therefore the ratio is inherently controlled (Example 1 and 2). Iida et al also discloses in order to establish the N region over the entire cross section of a crystal, a highly precisely control must be carried out. Also note that the entire reference has been incorporated into the basis of the rejection. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Asayama et al with Iida's controlling V/G to form a silicon ingot with a desirable N-region over the entire cross section ('264 col 5, ln 1-20).

Hourai et al discloses a V/G ratio of 0.183-0.177 mm^2/K min (Fig 2), where dislocation clusters form through the entire wafer, this reads applicant's N-region, where wafers are formed from a silicon single crystal ingot manufactured by the Czochralski method with careful control of the pulling rate and temperature gradient permit a crystal to be formed that is free of Oxidation induced stacking fault rings and other defects (Abstract). Hourai et al also teaches V and G are important parameters for controlling the diameter of an OSF ring (col 4, ln 1-67). Also note the entire reference has been incorporated into the basis of the rejection. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Asayama et

al with Hourai's controlling V/G to form a silicon ingot with a desirable N-region over the entire cross section ('264 col 5, ln 1-20).

The combination of Asayama et al and Hourai et al or the combination of Asayama et al and Iida et al is silent to the silicon single crystal being pulled at a rate greater than the rate of pulling a silicon single crystal with no carbon doping. Iida et al teaches through the adequate adjustment of the pulling rate, the N region can be formed over the entire crystal cross section (col 5, ln 10-15), which is a teaching that pulling rate is a result effective variable for forming a N-region. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Asayama et al and Hourai et al or the combination of Asayama et al and Iida et al by optimizing the pulling rate to obtain a pulling rate greater than the rate of pulling a silicon single crystal with no carbon doping conducting routine experimentation of a result effective variable.

Referring to claims 9-10, it is noted that claim 9 is a product claim, which recites process limitations. The patentability determination of a product-by-process claim is based on the patentability of the product and does not depend on its method of production (MPEP 2113). Therefore, the product taught by the combination of Asayama et al and Hourai et al or the combination of Asayama et al and Iida et al reads on the instantly claimed silicon wafer because the product limitations are taught by the combination of Asayama et al and Hourai et al or the combination of Asayama et al and Iida et al.

Response to Arguments

10. Applicant's arguments with respect to claims 1-10 have been considered but are moot in view of the new ground(s) of rejection.

11. Applicant's arguments filed 10/14/2003 have been fully considered but they are not persuasive.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., compensation of the weak point of doping nitrogen by doping with carbon to obtain a synergistic effect (pg 4)) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

In response to applicant's argument that the combination of Iida et al Fujikawa et al or the combination of Hourai et al and Fujikawa et al, the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). The combination of Iida et al Fujikawa et al or the combination of Hourai et al and Fujikawa et al teaches doping a silicon single crystal with carbon and adjusting the pulling rate to obtain a N-region over the entire crystal cross section ('264 col 5, ln 10-15); therefore the increase pulling rate for a carbon doped ingot would be obvious because the combination of Iida et al Fujikawa et al or the combination of Hourai et al and Fujikawa et al teach adjusting the pulling rate to obtain the N-region.

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Minami et al (US 6,517,632) teaches doping a silicon using a Czochralski method with carbon and nitrogen, note abstract.

Togashi et al (US 2003/0068502) claims growing a perfect silicon single crystal ingot and doping with nitrogen, note claims 4-5.

Tamatsuka et al (US 6,478,883) teaches doping a silicon single crystal growing by the Czochralski method with nitrogen (Abstract).

Tamatsuka (US 6,224,668) teaches doping a silicon single crystal growing by the Czochralski method with nitrogen (Abstract).

Iida et al (US 2003/0015131) is a pending application with a common assignee and claimed maintaining V/G ratio and doping with nitrogen, note claims 8-22.

Pyi (US 2003/0079677) teaches doping a silicon ingot with carbon (Abstract).

Kirscht et al (US 6,491,752) teaches co-doping a silicon ingot with carbon (Abstract).

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS

SUPERVISOR
NADINE G. NORTON
PRIMARY EXAMINER

Nad Nort